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# Gene Effect on Yield and Yield Components of Five Bread Wheat Crosses.

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## ABSTRACT

**The present investigation was carried out at the Experimental Farm Research, Station of Nubaria during three successive seasons starting 2002/2003 through 2004/2005 to evaluate grain yield, its components and some growth traits in five inter varietal crosses of bread wheat *(Triticum aestivum L.)*and their six populations ($P_1$, $P_2$, $F_1$, $F_2$ $Bc_1$ and $Bc_2$).**

**Significant positive heterotic effects referring to the better parent were detected for days to heading in all crosses except for the first cross, number of spikes plant$^{-1}$, number of grains spike$^{-1}$ and spike weight in all crosses, grain yield plant$^{-1}$ in the second, third and fifth crosses and 1000-grain weight in the fifth cross only. However, negative heterotic effects were detected for plant height in all crosses, grain yield plant$^{-1}$ in the first and fourth crosses, 1000 – grain weight in all crosses except the fifth one.**

**Inbreeding depression estimates were significant for all crosses except the third cross for days to heading. There were overdominance effect towards the higher parents for days to heading in the first and fifth crosses, number of grains spike$^{-1}$ and spike weight in all crosses except the fourth cross and grain yield in the first and fifth crosses. Partial dominance towards the lower parents for plant height in the second and fourth crosses, grain yield plant$^{-1}$ in the fourth cross only, 1000 – grain weight in the second and third crosses. Additive gene effects were positive and significant for number of spikes plant$^{-1}$ in the fourth and fifth crosses, grain yield plant$^{-1}$ in the third and fifth crosses, 1000 – grain weight in the first, second and third crosses, respectively. Additive x additive gene action was significant for heading date in the first, second, fourth and fifth crosses and grain yield plant$^{-1}$ in the first cross only. Both the $F_2$ deviation ($E_1$) and backcross deviation ($E_2$) were significant for most characters. Heritability estimates in broad sense ranged from 4.22% for grain yield plant$^{-1}$ in the first cross to 82.19% for 1000-grain weight in the fourth cross, however heritability in narrow sense ranged from 39.66% for number of grains spike$^{-1}$ in the second cross to 96.08% for number of spikes plant$^{-1}$ in the first cross. Low to high genetic advance were found to be associated with low to high narrow sense heritability estimates in all studied traits.**


## INTRODUCTION

Wheat is considered the most important cereal crop in the world and Egypt. It is used for making bread, bakeries, animal feeding and other industrial purposes. In Egypt, there is a large gap between wheat production and the total human consumption. Genetic improvement is an important approach to increase grain yield and its attributes through breeding program.

Inheritance of grain yield and most yield components belong to quantitative inheritance theory, which help breeders determining the genetic parameters for these traits to achieve their goals of breeding programs in all crops, especially wheat.

Many researchers such as Mather (1949), Gamble (1962), Petr and Frey (1966) and Mather and Jinks (1971) concluded that maximum progress for improving any trait would be expected in a selection program, when the additive gene action was the main component of the genetic variance, while the presence of non-additive gene action could suggest the use of hybridization program to achieve this goal. So the mentioned researchers set up many genetic models for different breeding purposes.

This investigation was carried out to determine the type of gene action and some genetic parameters in five wheat crosses derived from five parental wheat genotypes (two local and three exotics) using the six population methodology of each cross.

## MATERIALS AND METHODS

The present study was conducted in the Farm of Nubaria Research Station, wheat Research Department, during the period from 2002 to 2005. The five crosses were used in the present study were derived from five parental wheat cultivars or lines. The pedigree of the five parents used in the study are given in the following table.

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| No. | Source | Pedigree |
|---|---|---|
| P1 | ESWYT 22 2001-02 | PRINIA / STAR<br>CMSS 92 M005795-015M-0y-050M-10Y-1M-0y |
| P2 | ESWYT 44 2001-02 | PVN/CAAR 422/ ANA/S/BOW/CROW// BUC/ PVN/3/ YR/4/……..<br>CG65-099Y-099M-8Y-6M-1Y-0B |
| P3 | HRWYT 37 2001-02 | MILAN/DUCULA<br>CMSS 93 B010755-74Y-010M-010Y-010M-8Y-35J-0Y. |
| P4 | Gemmiza 7 | CMH 74A-63015 X //SERI 82 / 3 / AGent<br>CGM4611-2GM-3GM-1GM-0GM |
| P5 | Giza 168 | MRL / Buc / SERI<br>CM93046-8M-0Y-0M-2Y-0B |

In the first season (2002/03), five crosses were performed to obtain $F_1$ seeds. These crosses are (P1 * P4),(P2*P4),(P3*P4),(P1*P5) and (P3*P5). In the next season, 2003/04, the $F_1$ and two parents from each cross were grown together in two rows. Part of the $F_1$ plants were back crossed to their two respective parents to produce first and second back crosses ($Bc_1$ and $Bc_2$), while the other part of $F_1$ plants were selfed to obtain $F_2$ seeds. Fresh seeds of $F_1$ from each cross were obtained by crossing their two parents, at the end of this season enough seeds from the $F_1$, $F_2$, $Bc_1$ and $Bc_2$ were obtained from each of the five crosses. In the third season (2004/05) seeds of the six populations $P_1$, $P_2$, $F_1$, $F_2$, $Bc_1$ and $Bc_2$ of the five crosses were evaluated in three adjacent blocks. Each block contained the six generations of each cross grown in rows of 200 cm in length, 20 cm apart with 5 cm between plants. Each generation was grown in 3 rows except $F_2$ which was presented by 5 rows. At harvest random 20 plants were chosen from each block for the $P_1$, $P_2$, $F_1$, $Bc_1$ and $Bc_2$ generations, while 50 plants were taken from the $F_2$ generation within each block to study the following traits:

Days to heading, plant height, number of spikes plant$^{-1}$, number of grains spike$^{-1}$, spike weight, grain yield plant$^{-1}$ and 1000-grain weight for each generation.

Various biometrical parameters were calculated only if the $F_2$ genetic variance was found to be significant. Heterosis (%) was determined as the percent increase of $F_1$ over the mid, latrer and taller-parent, according to the formula adopted by Bhatt (1971). Inbreeding depression (ID %) was estimated as the average percentage decrease of $F_2$ generation compared to the $F_1$ hybrid according to Mather and Jinks (1971). Genetic analysis of generation means to give estimates of mean effect parameter (m), additive (a) and dominance (d) effects were obtained by the method illustrated by Gamble (1962). In addition, $F_2$-deviation ($E_1$) and backcross deviation ($E_2$) were estimated as suggested by Mather and Jinks (1971). Heritability was calculated in both broad-and narrow-senses according to Mather's procedure (1949). The genetic gain from selection, as an indication of the $F_2$ mean performance, was obtained according to Miller *et al.* (1958). The predicted genetic advance from selection was estimated using the formula presented by Johanson *et al.* (1955). Potance Ratio (P) was also calculated according to Petr and Frey (1966).

## RESULTS AND DISCUSSION

Varietal differences, in response to their genetic background, were found to be significant for most traits under investigation. The genetic variance within $F_2$ population was also found to be significant for all studied traits in the five crosses, therefore the different biometrical parameters used in this investigation were estimated. Means and variances of the six populations, i.e., $P_1$, $P_2$, $F_1$, $F_2$, $BC_1$ and $BC_2$ for the studied traits in the five crosses are presented in table (1).

Heterosis, inbreeding depression percentage, potance ratio and different gene action parameters in the five crosses for the seven studied traits are given in Table (2). Significant positive heterotic effects to mid-parent were found for most traits in the five crosses except significant negative heterotic effects for plant height in the first, second, third and fifth crosses, grain yield and 1000-grain weight in the first cross only. Insignificant heterotic effect was found for grain yield plant$^{-1}$ in the fourth cross only. Heterotic effects in the first cross ranged from -29.93% for grain yield plant$^{-1}$ to 23.93% for spike weight, while they ranged from -3.41% for plant height to 22.67% for No. of grains spike$^{-1}$ in the second cross. In the third cross, the heterotic effects ranged from -5.33% for plant height to 28.06% for spike weight. In the fourth cross, the heterotic effect ranged from 0.5% for grain yield plant$^{-1}$ to 22.57% for spike weight, while they ranged from -4.15% for plant height to 21.42% for grain yield plant$^{-1}$ in the fifth cross.

With respect to heterotic effects relative to the better parent, data in Table (2) revealed that there were positive significant heterotic effects in most traits except

plant height in all crosses, grain yield plant$^{-1}$ for the first and fourth crosses and 1000-grain weight for the first, second, third and fourth crosses, respectively. With regard to days to heading, all crosses showed significant positive effects except the first cross, which had insignificant effect. Heterotic effects ranged from 0.57% to 14.73% in the first and second crosses, respectively. On the other hand, the five studied crosses showed negative heterotic effects ranging from -10.96% to -0.51% for plant height. Similar trend was observed for 1000-grain weight character, where the heterotic effect ranged from -12.17% in the first cross to 2.43% in the fifth one. As for number of spikes plant$^{-1}$, all crosses had significant positive heterotic effects (5.1 to 21.54%). Number of grains spike$^{-1}$ recorded similar trend, where the heterotic effect was positive and ranged from 8.81% to 18.51% in the fifth and second crosses, respectively. With respect to spike weight trait, it had significant positive heterotic effects in the five crosses, the heterotic effects ranged from 10.41% in the fifth cross to 24.92% in the third cross.

On the other hand, only the first and fourth crosses showed significant negative heterotic effect (-31.79% and -11.63%), respectively, for grain yield plant$^{-1}$, while the other three crosses showed Significant positive effects that ranged from 6.06% to 18.08% for the second and third crosses, respectively.

Number of spikes plant$^{-1}$, number of grains spike$^{-1}$ and 1000 – grain weight are considered the main components of grain yield plant$^{-1}$. Hence, heterotic increase, if found in one or more of the three yield components, may lead to favourable yield increases in hybrids. In this respect, the five crosses showed significant positive heterotic effects for both number of spikes plant$^{-1}$ and number of grains spike$^{-1}$, while the fifth cross had significant heterotic effect for 1000-grain weight also. These results are in close harmony with those recorded by Younis *et al.* (1988), Hendawy (1994), Hassan and Saad (1996), Darwish (1998), Abd El-Aty (2000), Abd El-Aty (2002) and Darwish and Ashosh (2003).

With regard to inbreeding depression, significant negative values were found for days to heading in all crosses, except the third one which had a positive value, plant height in all crosses had positive values, number of spikes plant$^{-1}$ showed significant negative values in all crosses except the fourth one, number of grains spike$^{-1}$ recorded significant negative values in all crosses except the first and third crosses, spike weight showed significant negative values in the second, third and fourth crosses, grain yield plant$^{-1}$ observed significant negative values in the first three crosses, but 1000-grain weight showed significant positive values in the first three crosses. This was logic, since the expression of heterosis in $F_1$ will be followed by considerable reduction in $F_2$ performance. The obtained results for most cases were in harmony with the conclusions reached by Gautam and Jain (1985) and Khalifa *et al.* (1997).

Significant heterosis and insignificant inbreeding depression were obtained for days to heading in the third cross only. Heterosis and Inbreeding depression coincided with the same particular phenomenon; therefore it is logic to anticipate that heterosis in the $F_1$ will be followed by an appreciable reduction in the $F_2$ performance. The contradiction between heterosis and inbreeding depression estimates could be due to the presence of linkage exists between genes in these materials (Van der Veen, 1959).

The potance ratio (Table 2) indicates the overdominance towards the higher parent for days to heading in the first and fifth crosses, number of grains spike$^{-1}$ and spike weight in all crosses except the fourth one and grain yield plant$^{-1}$ in the first and fifth crosses. Partial dominance towards the higher parent was found for plant height in the second cross, while partial dominance towards the lower parent were detected for plant height and grain yield plant$^{-1}$ in the fourth cross and in the second and third crosses for 1000 –grain weight. Overdominance was obtained for plant height by Ketata *et al.* (1976), Tamam (1989) and Mosaad *et al.* (1990); for number of spikes plant$^{-1}$ by Abu-Nass *et al.* (1991); for number of grains spike$^{-1}$ by Al-Kaddoussi *et al.* (1994), for grain yield plant$^{-1}$ by Al Kaddoussi *et al* (1994) and Eissa *et al.* (1994); for 1000 – grain weight by Rady *et al.* (1981), Al-Kaddoussi (1994), Ashoush (1996) and Moustafa (2002). Partial dominance towards the lower parent was reported for plant height by Eissa *et al.* (1994) and Moustafa (2002); for number of spikes plant$^{-1}$; number of grains spike$^{-1}$ and 1000-grain weight by Moustafa (2002).

Nature of gene action was investigated according to the relationships illustrated by Gamble (1962). The estimated mean effect parameter (m), which reflects the contribution due to the over-all mean plus the locus effect and interactions of the fixed loci, was found to be highly significant for all studied characters in all crosses. The additive gene effects were found to be significant and positive for number of spike plant$^{-1}$ in the fourth and fifth crosses, grain yield plant$^{-1}$ in the third and fifth crosses, and 1000 –grain weight in the first, second and third crosses. Suggesting the potential for obtaining further improvements of that traits using pedigree selection program. Significant negative additive effect

was obtained for number of spikes plant$^{-1}$ and grain yield plant$^{-1}$ in the first cross in the two traits, indicating that the additive effects were less important in the inheritance of that trait.

Dominance gene effects were found to be significant for days to heading only in the five crosses. When dominance gene is present, it would tend to favor the production of hybrids, while the existing of the additive gene action in the gene pool encourages the improvements of the character by selection program. Highly significant positive additive x additive types of epistasis was detected for days to heading in all crosses except the third one and for grain yield plant$^{-1}$ in the first cross only. Additive x dominance epistatic types were significant or highly significant and positive for number of spikes plant$^{-1}$ in the second, fourth and fifth crosses, and 1000 – grain weight in the second, third and fifth crosses. Dominance x dominance types of gene action was found to be negative significant for days to heading in all crosses, and grain yield plant$^{-1}$ in the first and second crosses.

Significant positive $F_2$ deviation ($E_1$) were found for days to heading in the second and third crosses, plant height in all crosses except for the fifth cross, number of grains spike$^{-1}$ in the first and third crosses, spike weight in the first, fourth and fifth crosses, grain yield plant$^{-1}$ in the third, fourth and fifth crosses, 1000 –grain weight in the first, second and third crosses, while significant negative values were obtained for days to heading in the first, fourth and fifth crosses, plant height in the fifth cross only, number of spikes plant$^{-1}$ in the first, second and fourth crosses, number of grains spikes$^{-1}$ in the second cross only, grain yield plant$^{-1}$ in the first and second crosses, 1000 –grain weight in the fourth and fifth crosses, (Table 2). These results may refer to the contribution of epistatic gene effects in performance of these traits. On the other hand, insignificant $F_2$ deviations were detected for number of spikes plant$^{-1}$ in the third and fifth crosses, number of grains spike$^{-1}$ in the fourth and fifth crosses, spike weight in the second and third crosses. This may indicate that epistatic gene effects had major contribution in the inheritance of these traits.

Backcross deviations ($E_2$) were found to be positive and significant for days to heading in all crosses, plant height in the first, second and fourth crosses, number of spikes plant$^{-1}$ in the third and fourth crosses, number of grains spike$^{-1}$ in all crosses, spike weight in the first and second crosses, grain yield – plant$^{-1}$ in all crosses, 1000-grain weight in the first and third crosses. On the other hand, significant negative ($E_2$) detected for plant height in the third and fifth crosses, number of spike plant$^{-1}$ in the second cross only, spike weight in the third, fourth and fifth crosses, 1000 – grain weight in the fourth and fifth crosses. While insignificant backcross deviations ($E_2$) values were detected for number of spikes plant$^{-1}$ in the first and fifth crosses, 1000 – grain weight in the second cross only. These results would ascertain the presence of epistasis in such magnitude as to warrant great deal of attention in a breeding program.

Heritability in both broad and narrow senses and genetic advance under selection are presented in Table (3). Lush (1994) gave the term heritability to define the relation between genotypic and phenotypic variances as broad sense heritability, and the relation between additive and phenotypic variance as narrow sense heritability. Heritability values are important to the breeder since it quantifies the accepted improvement from selection. To achieve genetic improvement through selection, heritability must be reasonably high. In the present investigation, heritability estimates, in broad sense ($h^2b$) were low to high in magnitude with values ranging between 4.22% for grain yield plant$^{-1}$ in the first cross, to 82.19% for 1000 – grain weight in the fourth cross. For days to heading the third, fourth and fifth crosses, plant height the second, third, fourth and fifth crosses, number of spike plant$^{-1}$ the second, third and fourth crosses, number of grains spike$^{-1}$ in the five crosses, spike weight in the third and fourth crosses, and 1000-grain weight in the first, second, fourth and fifth crosses, high estimates of broad sense heritability were detected. Narrow sense heritability ($h^2n$) estimates ranged from 39.66% for number of grains spike$^{-1}$ in the second cross, to 96.08% for number of spikes plant$^{-1}$ in the first cross. Similar results were obtained by Mosaad *et al.* (1990), Gouda *et al.* (1993), Ashoush (1996), El-Hosary *et al.* (2001), Moustafa (2002) and Darwish *et al.* (2006).

Genetic advance under selection (Δg%) was found to be high in magnitude in the first cross for number of spikes plant$^{-1}$ and grain yield plant$^{-1}$, the second and third crosses for number of spikes plant$^{-1}$, spike weight and grain yield plant$^{-1}$, the fourth cross for spike weight only and fifth cross for number of grains spike$^{-1}$. Relatively low gains were found in the first and second crosses for days to heading and plant height, the third cross for days to heading, plant height and 1000 – grain weight, the fourth cross for heading date and plant height, and the fifth cross for heading date, plant height and 1000 – grain weight. Dixi *et al.* (1970) pointed out that high heritability is not always associated with high genetic advance, but in order to make effective selection, high heritability should be associated with high genetic gain. In this study, high to moderate genetic

advance were found to be associated with high to moderate narrow sense heritability estimates in the five crosses.

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## الملخص العربي

# التأثير الجينى لمحصول الحبوب ومكوناته فى خمسة هجن من قمح الخبز

سهير محمود حسن عبد الله


تم تنفيذ هذه الدراسة بمحطة البحوث الزراعية بالنوبارية فى ثلاثة مواسم متتابعة 2003/2002حتى2005/2004 لتقييم محصول الحبوب ومكوناته وبعض صفات النمو لخمسة هجن صنفية من قمح الخبز بحيث كان لكل هجين ست عشائر هى الأبوان والجيلان الأول والثانى والجيلان الرجعيان0 وقد أوضحت النتائج أن قوة الهجين مقارنة بالاب الأعلى كانت معنوية وموجبة لصفة عدد الأيام حتي طرد السنابل فى كل الهجن ماعدا الهجين الأول، كذلك كانت معنوية وموجبة لكل الهجن لصفات: عدد السنابل/ نبات، عدد الحبوب/ السنبلة، وزن السنبلة، وصفة محصول الحبوب/ النبات فى الهجين الثانى والثالث والخامس، كذلك بالنسبة لصفة وزن الألف حبة فى الهجين الرابع فقط0

بينما كانت قوة الهجين سالبة لكل من: طول النبات فى جميع الهجن، محصول الحبوب/ النبات فى الهجين الأول والرابع، صفة وزن الألف حبه فى جميع الهجن ماعدا الهجين الخامس0

أظهر معامل التربية الداخلية معنوية فى جميع الصفات تحت الدراسة ماعدا صفة عدد الأيام حتي طرد السنابل فى الهجين الثالث0 كانت هناك سيادة فائقة فى إتجاه الأب الأعلى فى صفة عدد أيام الطرد للهجين الأول والخامس، عدد الحبوب/ السنبلة فى جميع الهجن ماعدا الهجين الرابع، وزن السنبلة فى جميع الهجن ماعدا الهجين الرابع ومحصول الحبوب/ النبات فى الهجين الأول والخامس0

وكانت هناك سيادة جزئية فى أتجاه الأب المنخفض فى صفة طول النبات فى الهجين الثانى والرابع، محصول الحبوب/ نبات فى الهجين الرابع فقط، صفة وزن الألف حبة فى الهجين الثانى والثالث0

كان التأثير المضيف معنويا وموجبا لصفة عدد السنابل/ نبات فى الهجين الرابع والخامس، محصول الحبوب فى الهجين الثالث والخامس، صفة وزن الألف حبة فى الهجين الأول ، الثانى والثالث على الترتيب0كان التأثير المضيف معنويا وموجبا لصفة عدد السنابل/ نبات فى الهجين الرابع والخامس، محصول الحبوب/ نبات فى الهجين الثالث والخامس، صفة وزن الألف حبة فى الهجين الأول، الثانى والثالث على الترتيب0 بينما كان نوع التفاعل (المضيف x المضيف) معنويا لصفة عدد أيام الطرد فى الهجين الأول ، الثانى ، الرابع والخامس، ومحصول الحبوب/ نبات فى الهجين الأول فقط0

تراوحت قيم معامل التوريث بمعناها الواسع بين 2ر4% لصفة محصول الحبوب/ نبات فى الهجين الأول، إلى2ر82% لصفة وزن الألف حبة فى الهجين الرابع، بينما تراوحت قيم معامل التوريث بمعناها الضيق بين 7ر39% لصفة عدد الحبوب/ نبات فى الهجين الثانى إلى 1ر96% لصفة عدد السنابل / نبات فى الهجين الأول – وقد إرتبطت قيم االتحسين الوراثى المنخفضة والمرتفعة بمثيلتها لمعامل التوريث بمعناه الضيق فى جميع الهجن تحت الدراسة0